Internship at the Laboratoire de Génie Chimique (LGC) in Toulouse

End-of-studies internship (6 months) – Starting date: To be defined in 2022

Subject: Study of the role of the biofilm matrix (exopolymeric substances) in the performance of microbial bioanodes

Keywords: Bioelectrochemical systems, Salt marsh electroactive biofilms, Exopolymeric substances, Current production, Quorum sensing, Stainless steel microelectrodes.

Host laboratory: Laboratoire de Génie Chimique - BIOSYM Department (Labège site: INP-ENSIACET Campus) – Biofilm Engineering Team - 4 allée Emile Monso 31030 Toulouse.

Scientific context:

The work carried out on bioelectrochemical systems (BES) has led to the emergence of a wide range of new possible applications for electroactive biofilms (EAB): energy conversion, wastewater and organic waste treatments, soil remediation and sensing. However, none of them has yet reached the industrialization stage, including the microbial fuel cell, a concept that was demonstrated nearly 20 years ago. One of the major problems highlighted is that the short-term sustainability of BES is intrinsically linked to the loss of the electrochemical activity of the EAB on electrodes. Multi-species EAB generally have a peak efficiency that drops beyond a few days to few ten days of operation.

The ANR MICROBE project (ANR-18-CE05-0024), in which this internship is integrated, focuses on improving the durability of the electrochemical activity of multi-species EAB for long-term applications of BES. A vital part of biofilms is the matrix, also called as exopolymeric substances (EPS), which their fundamental role in multi-species EAB has been barely studied to date. However, it is well established that EPS are particularly indispensable for the electrochemical activity of the biofilms[1]. As a preliminary action, an innovative protocol for determining the presence and the composition of the EPS on multi-species EAB has been developed from confocal microscopy imaging and successfully tested at the LGC.

Main objectives of the internship:

The aim of the proposed internship is to study the influence of diverse parameters that can be modified during the operation of a BES. The impact of these will be focused on the production and composition of EPS, as well as on the catalytic activity of the biofilm. Understanding their role in the formation of the exopolymeric matrix and on the matrix composition is essential to optimize the electrochemical performance of the EAB. A concrete expectation of the internship is, for example, to determine which composition of the bulk solution, known as the anodic electrolyte, promotes or inhibits the formation of the biofilm matrix and also what impact this has on the electrochemical response of the biofilm.

We would also like, in the framework of the internship, **to study the optimization of the electrochemical activity of multi-species EAB by the activation of quorum sensing (QS).** We propose to stimulate the molecular interactions between bacteria in the biofilm by adding commercially available quorum-sensing molecules to the electrolyte. It has been previously demonstrated that the activation of quorum sensing in EAB resulted in a doubling of current densities[2]. Furthermore, the impact of quorum sensing on matrix production by EABs has not yet been elucidated. This will represent a very original area of investigation for the internship.

From a practical point of view, the experimental work will be conducted in electroanalytical systems inoculated with microorganisms. Electroactive biofilms using salt marsh sediments will be formed on stainless steel microelectrodes. The catalytic activity of the biofilm will be monitored by controlled electrochemical techniques. The biofilms and the EPS production will be characterized by microscopic analysis (CLSM and SEM).

Candidate profile:

The internship subject is at the border of several scientific fields: process engineering, electrochemistry, microbiology, and microscopy. In any case, the candidate, curious, must have a strong interest in experimental and multidisciplinary work. Self-motivation, discipline, autonomy and communication are highly appreciated personal qualities.

Contacts: Applications (CV + motivation letter, academic transcripts) should be sent to Lucila Martinez Ostormujof (PhD student): lucila.marinezostormujof@toulouse-inp.fr

References:

1. *Xiao Y, Zhang E, Zhang J, et al. Extracellular polymeric substances are transient media for microbial extracellular electron transfer. Sci Adv. 2017;3(7):1-9. doi:10.1126/sciadv.1700623*

2. *Chabert N, Bonnefoy V, Achouak W. Quorum sensing improves current output with Acidithiobacillus ferrooxidans. Microb Biotechnol. 2018;11(1):136-140. doi:10.1111/1751-7915.12797*